IPE-409 CAD/CAM

Chapter-2

Defining the model

Introduction

❖ Models of form and models of structure

- Drawing of components and their arrangement in assemblies. Mechanical drawing of a part
- Diagram to show components of a system and how they are connected. Electronic circuit, chemical process etc.

Establishing design representation

Representation of form using drawing

- Representing 3D forms in 2D space by means of engineering drawing on paper or display
- Projecting views in mutually perpendicular planes
- Now 3D forms are represented in 2D by mapping points on the object in multiple mutually perpendicular planes
- Different line style meaning; Sectional view
- Third angle projection; First angle projection
- Pictorial projection; Parallel projection; Perspective projection

Establishing design representation

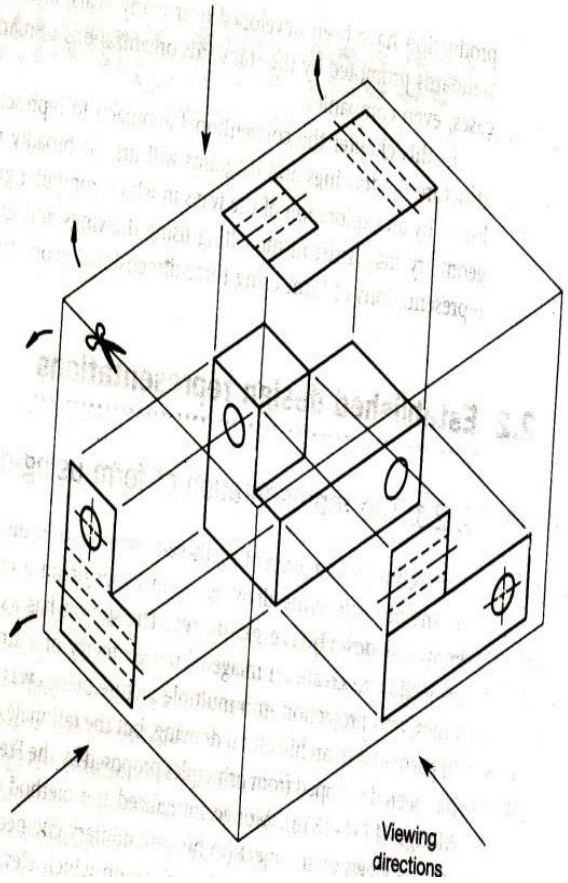


FIGURE 2.1
Orthographic projection of a simple shape.

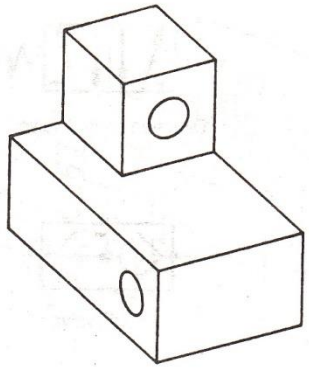


FIGURE 2.2
Parallel pictorial projection of a simple shape.

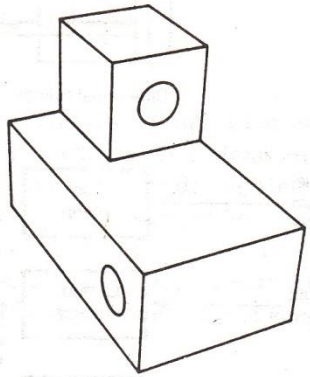
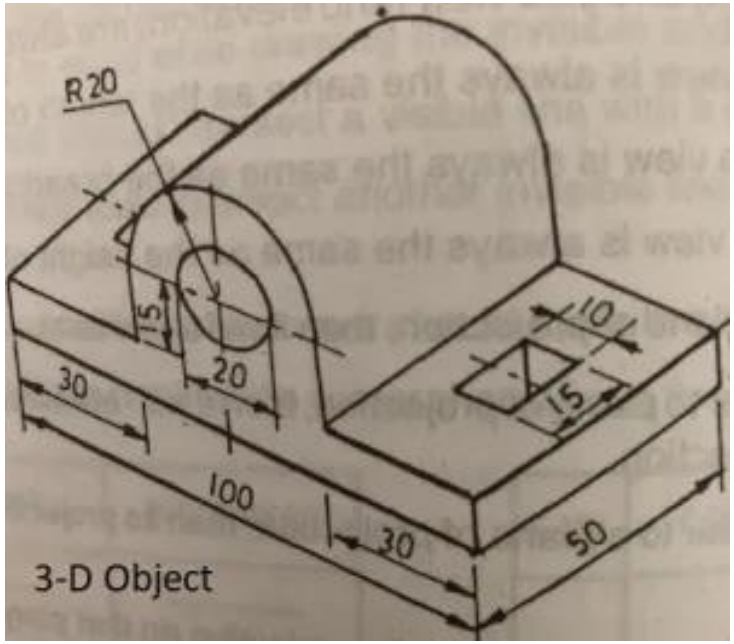
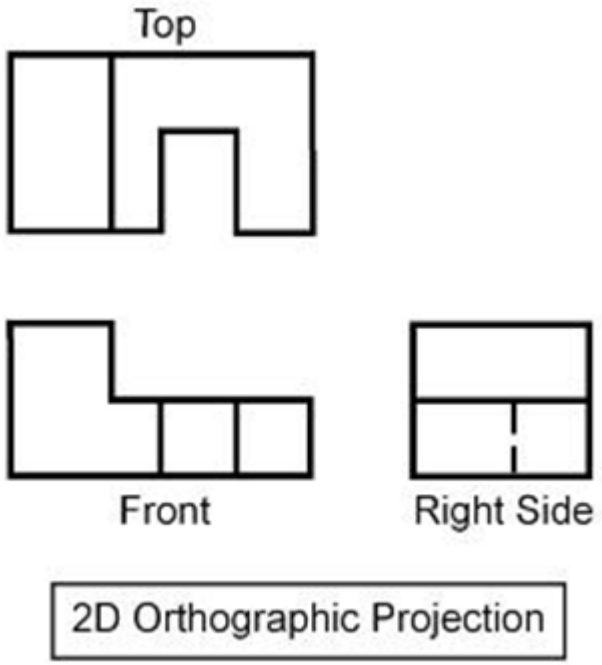


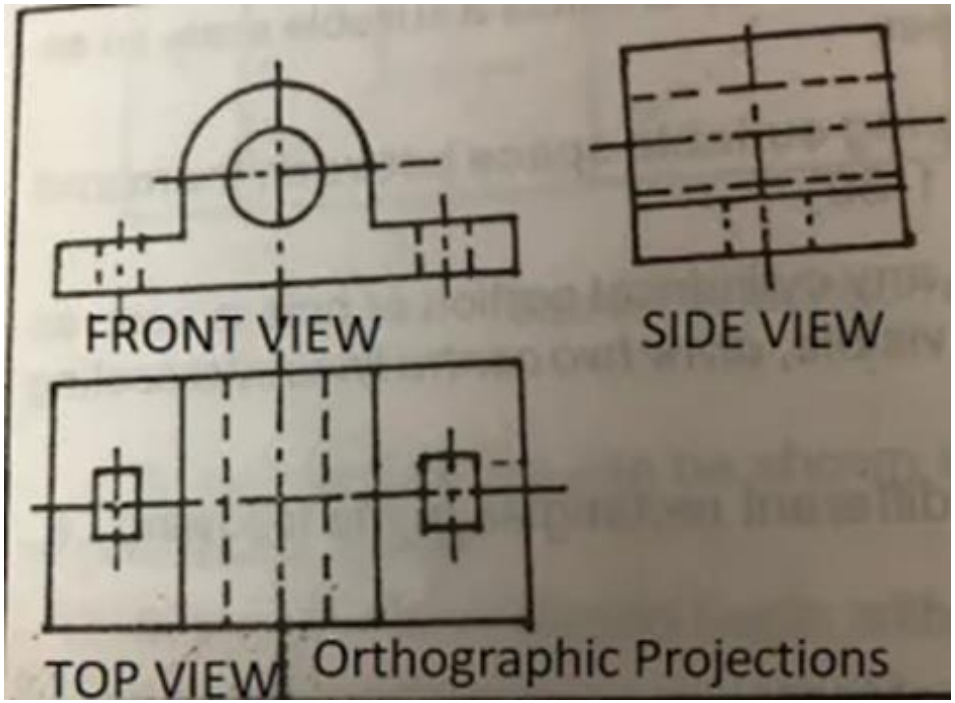
FIGURE 2.3
Perspective projection of a simple shape.

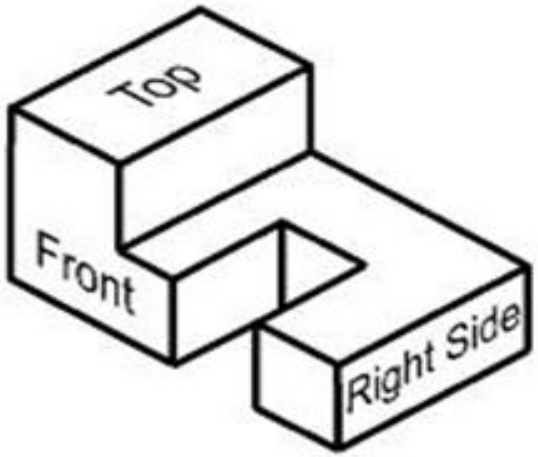
Establishing design representation





Establishing design representation





3D Representation

Strength and weakness of Conventional representations

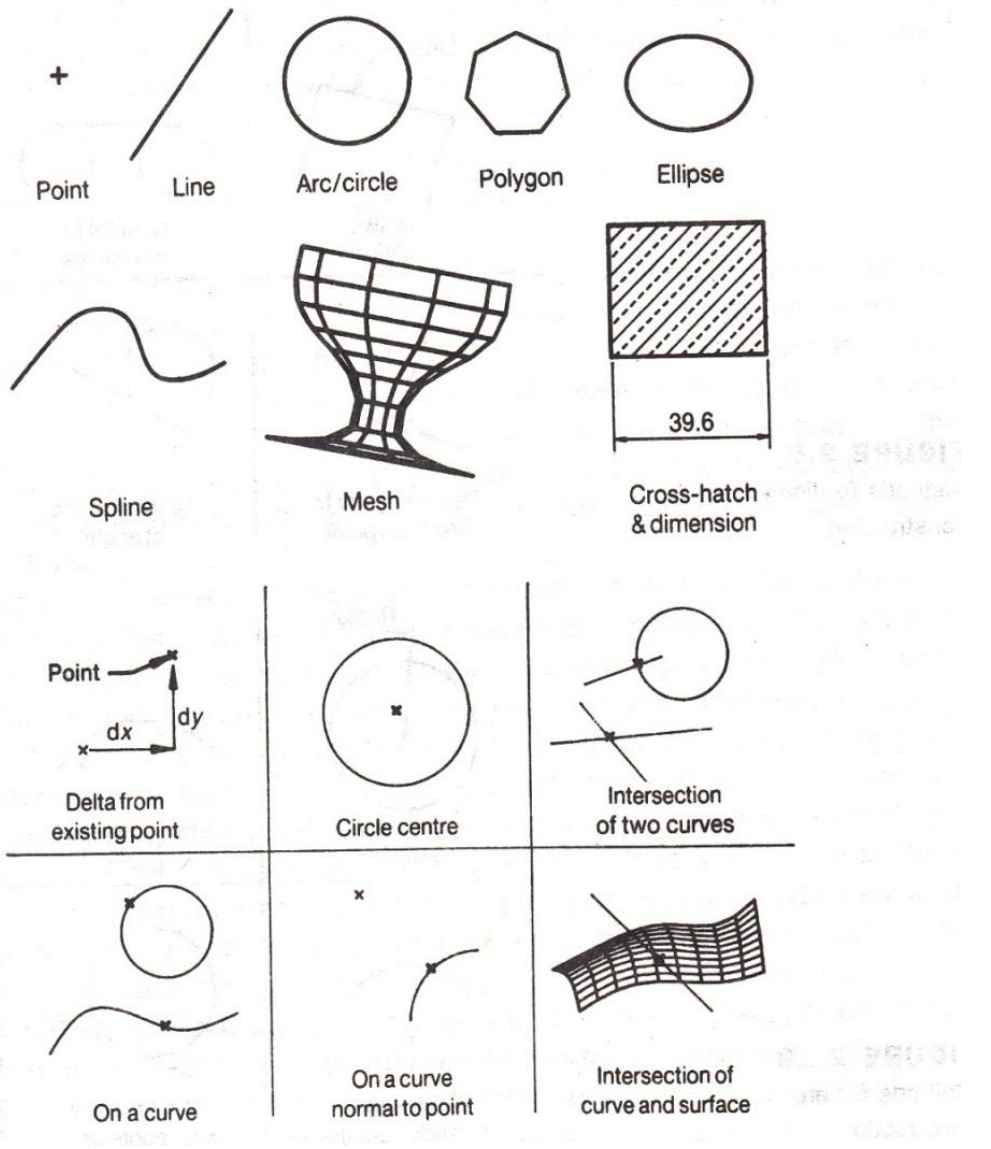
?

Computer Representation of Drawing

Computer-Aided Draughting

- Entities

- Methods for Point constriction



Computer-Aided Draughting

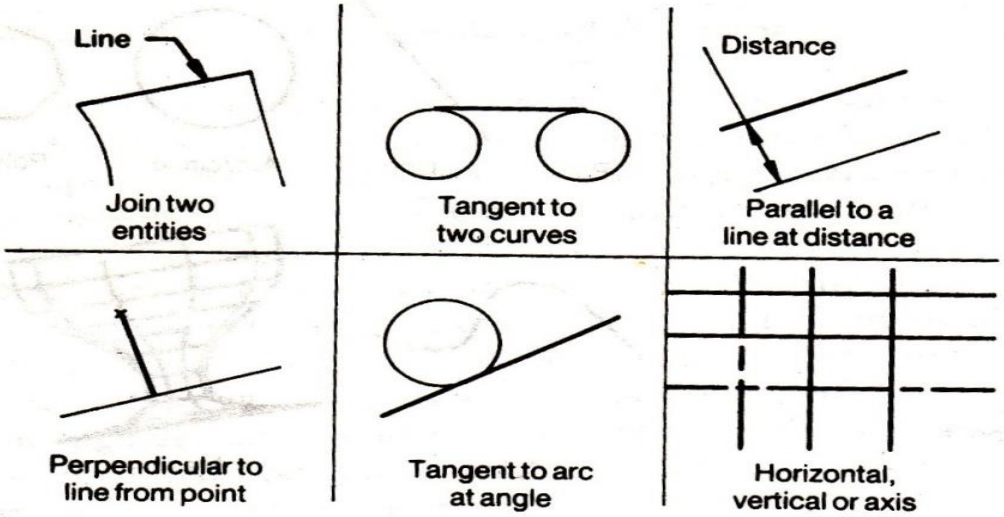


FIGURE 2.9
Methods for line construction.

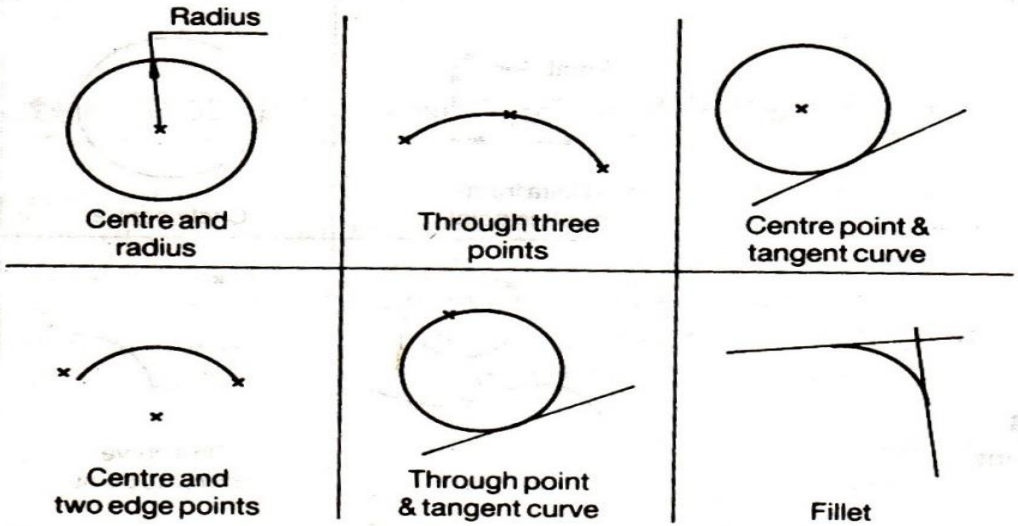


FIGURE 2.10
Methods for arc construction.

3D Modelling Schemes

- Coordinate systems: Cartesian coordinate system, Global coordinate system (GCS), Local coordinate system

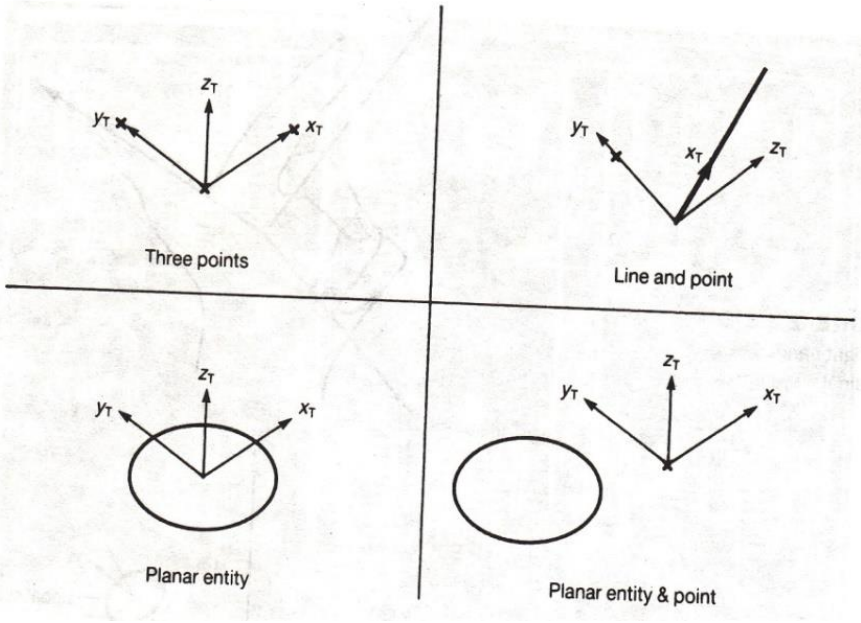


FIGURE 2.14
Methods for defining local coordinate systems.

Wire-frame geometry

- Relatively straight forward
- Less computer resource hungry
- Ambiguity in representation
- Deficiency in pictorial representation
- Limited ability to calculate geometric intersections or mechanical properties

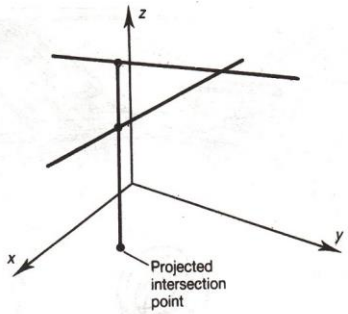


FIGURE 2.15 Projected intersection of entities.

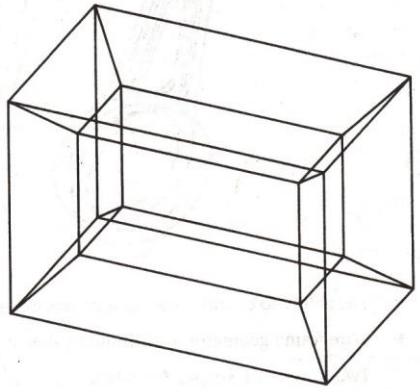


FIGURE 2.16 Ambiguity in wire-frame models.

Surface representation scheme

- Many ambiguity is are overcome by Surface modelling which involves representing the model by specifying some or all of the surfaces of the component.
- Flat surface may be defined by : two parallel lines, through three points or through a line and point.
- Other surface categories :
  - Surfaces are fitted to arrays of data points called control points and the surface is generated either to pass through or to interpolate the points.
  - Surfaces based on curves-the surface may be imagined as forming a skin on top of a wireframe skeleton
  - Surfaces are defined to interpolate between other surfaces

First category

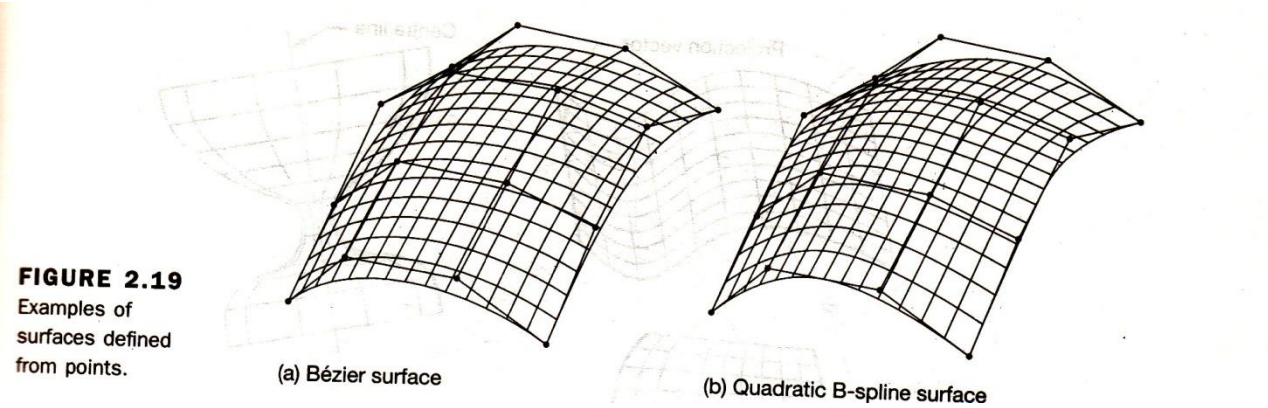


FIGURE 2.19
Examples of surfaces defined from points.

(a) Bézier surface

(b) Quadratic B-spline surface

Surface representation scheme

2nd Category

- Tabulated surface
- Ruled surface
- Surface of revolution
- Swept surface
- Curved mesh

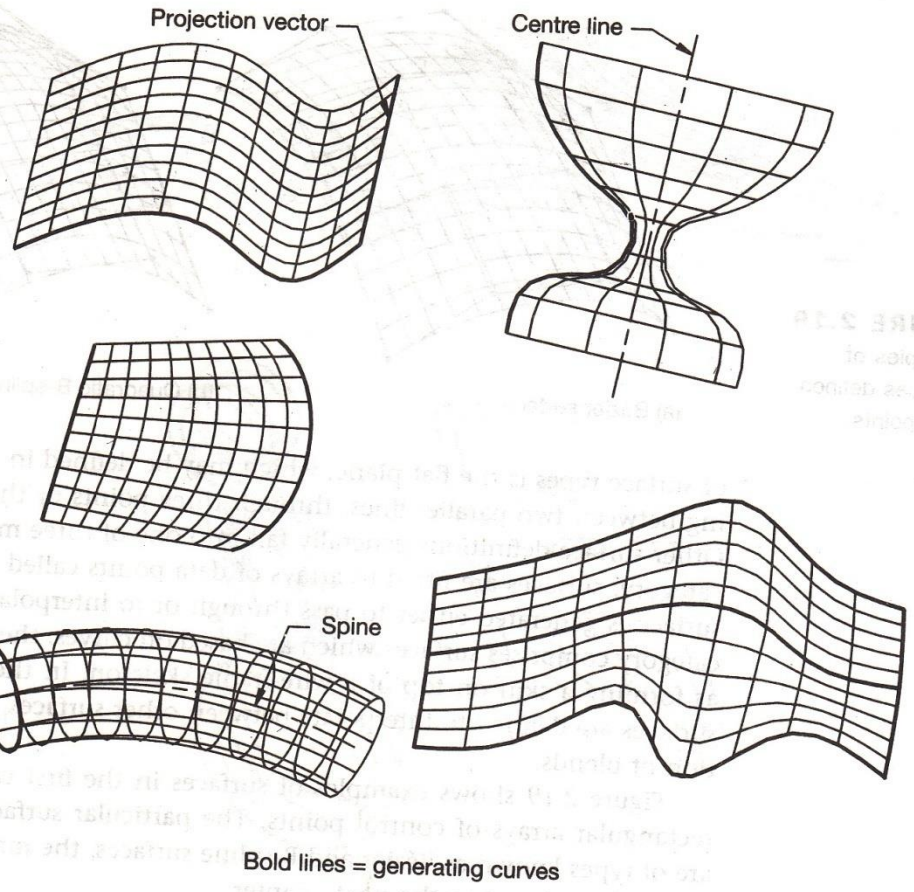


FIGURE 2.20
Examples of surfaces defined from curves.

Surface representation scheme

3rd Category

Surfaces are defined to interpolate between other surfaces

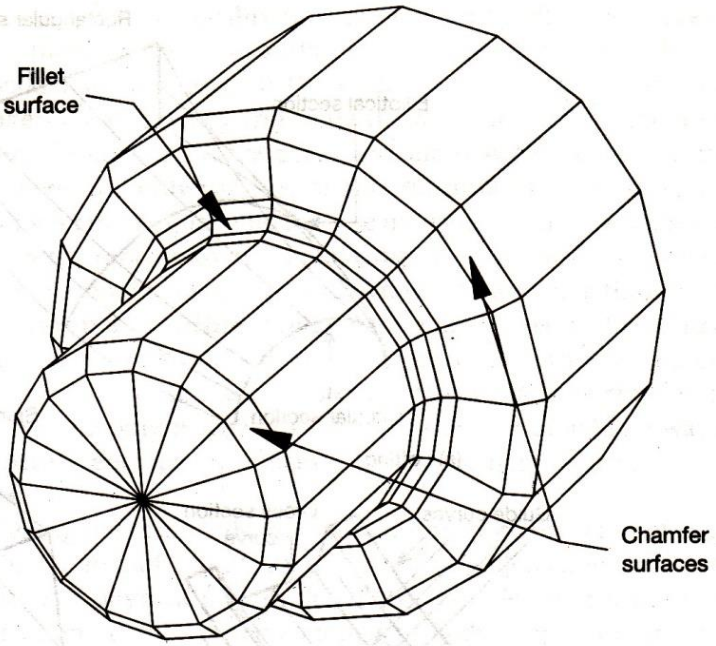


FIGURE 2.21
Examples of surfaces defined from other surfaces.

Surface representation scheme

- Surfaces are continuous, with every point on the surface defined by mathematical relationship used in its definition

- In general real artefacts are represented using surface geometry by an assemble of surface patch. A car body may require hundred of patched.

Surface representation scheme

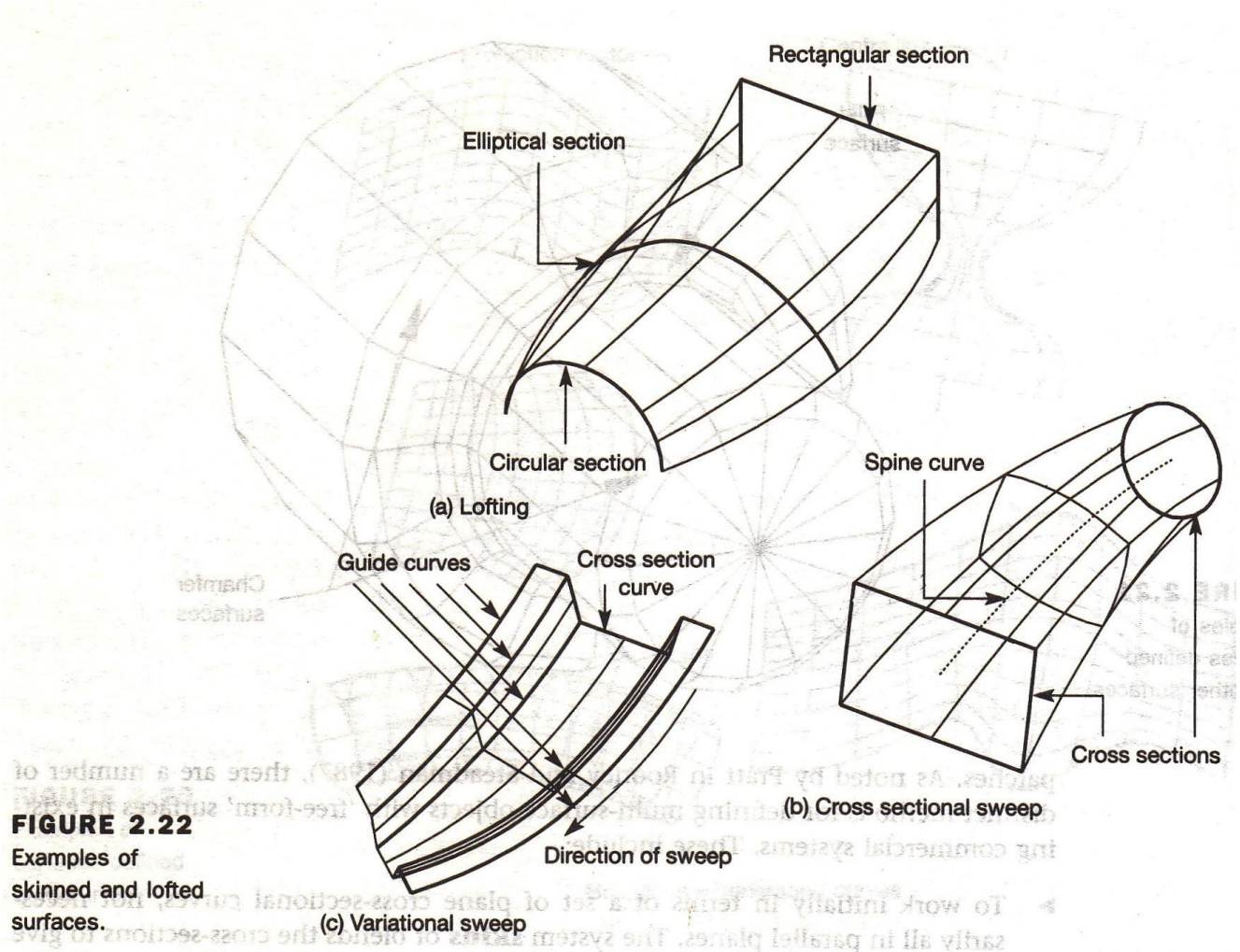


FIGURE 2.22
Examples of skinned and lofted surfaces.

Surface representation scheme

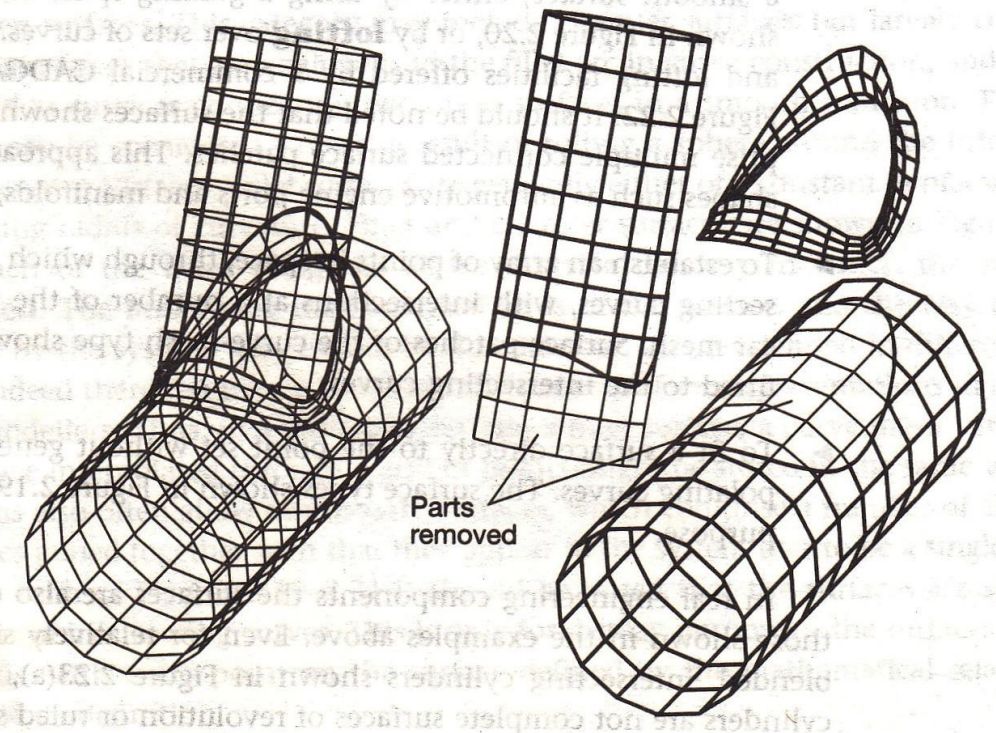


FIGURE 2.23
Filleted intersecting cylinders represented by trimmed surfaces.

(a) Trimmed surfaces

(b) Individual surfaces, indicating trimming

Applications, +ve, -ve

- Automobile, mould or die manufacture industries
- Shoe and garment industries
- Sheet metal works

- Ambiguity reduced
- Computationally demanding, requires more skills, difficult to interpret complex shapes
- Difficult to represent three or five sided patches

Solid Modelling

- Engineering analysis and generation of manufacturing information requires solid models.
- More complete the representation by Solid models. Smaller the risk of transcription errors
- Conditions for successful representation
  - Complete and unambiguous
  - Appropriate for engineering objects
  - Practical to use with existing computers
- Two major classes for solid modelling methods
  - Constructive Solid Geometry (CSG)
  - Boundary Representation (B-Rep)

CSG

- Use simple solid primitives- cuboids, cylinders, spheres, cones etc.
- Use set theory- union, intersection, difference
- Very compact, create solid models unambiguously
- Stored in unevaluated form. Computational issue for edges and surfaces

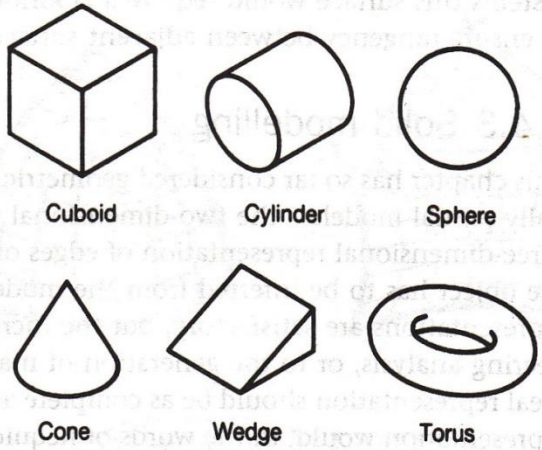


FIGURE 2.26
Primitives offered by a solid modelling system.

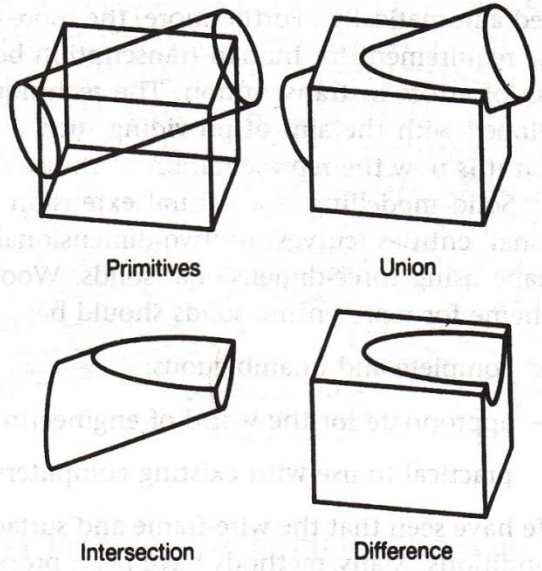


FIGURE 2.27
Boolean operations on a block and cylinder.

CSG

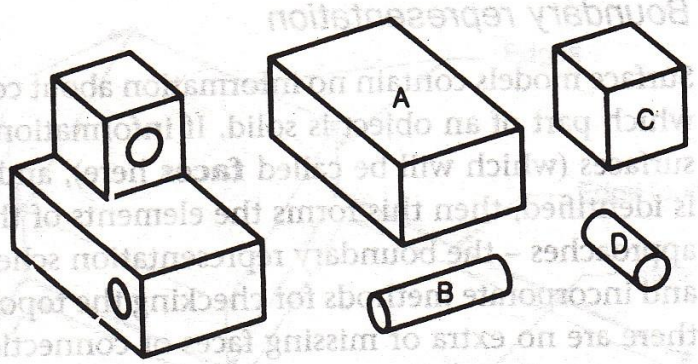


FIGURE 2.28
Constructive solid model of a simple block.

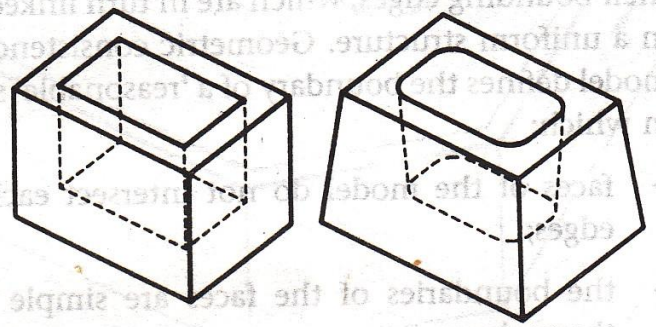
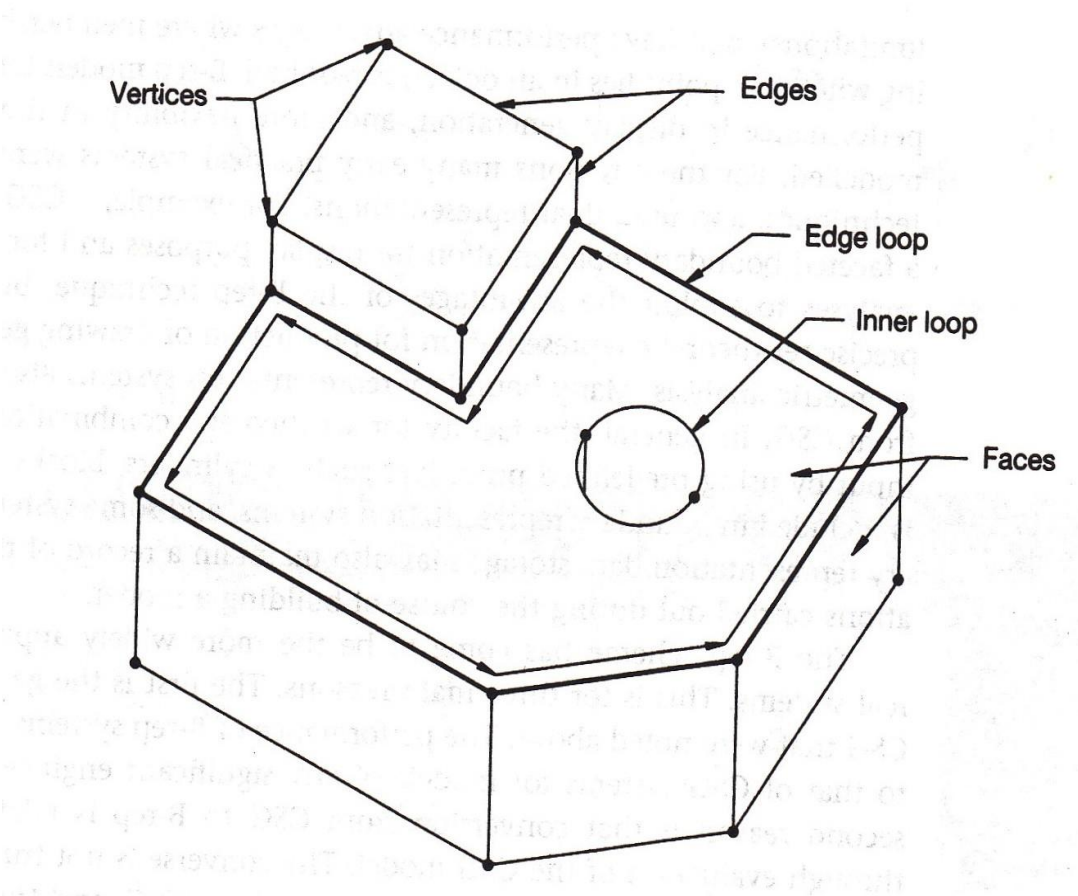


FIGURE 2.29
Solid models of a simple block.

...complex shapes may be developed relatively quickly, within the lim-

B-Rep

- Topological and Geometric consistency
- Faces of the model do not intersect other except at common vertices and edges
- Boundaries are simple loops of edges
- Set of faces of the model close to form the complete skin of the model with no missing parts



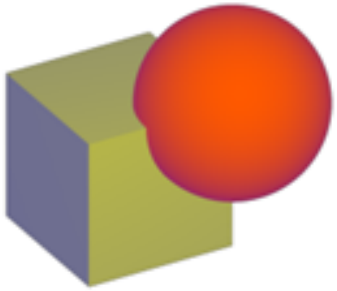
Advantages and Disadvantages of each system

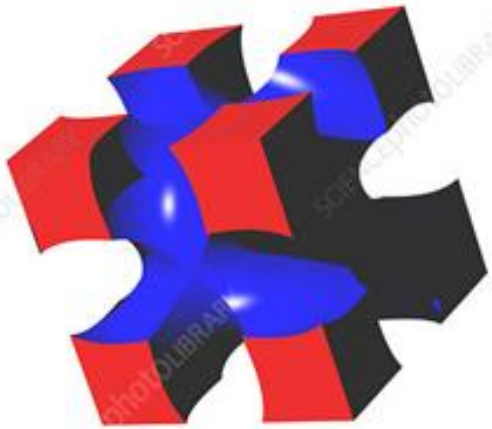
- CSG- Robust and have performance advantages where membership test is required.
- B-rep is better for display generation.

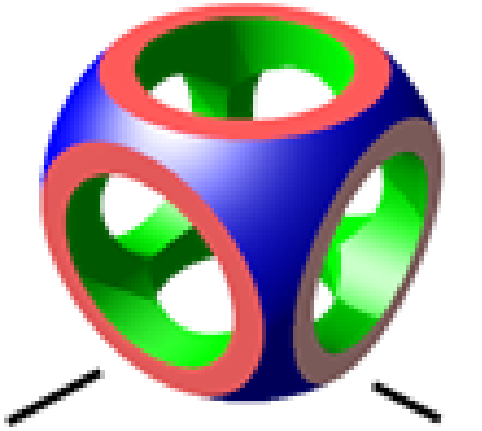
Why B-rep is more popular than CSG?

- First: Geometric limitations of CSG
- Second: Conversion from CSG to B-Rep is easy but B-Rep to CGS is difficult
- Third: Tendency for combining solid modeling with surface modeling and wire frame modeling

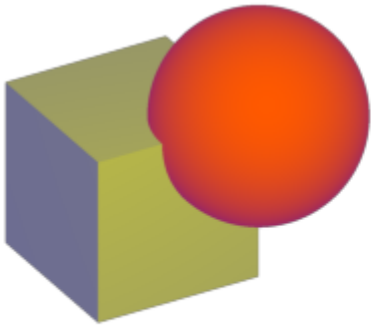
Assignment





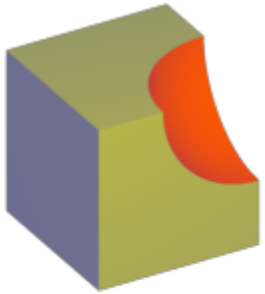


Boolean Operation Example



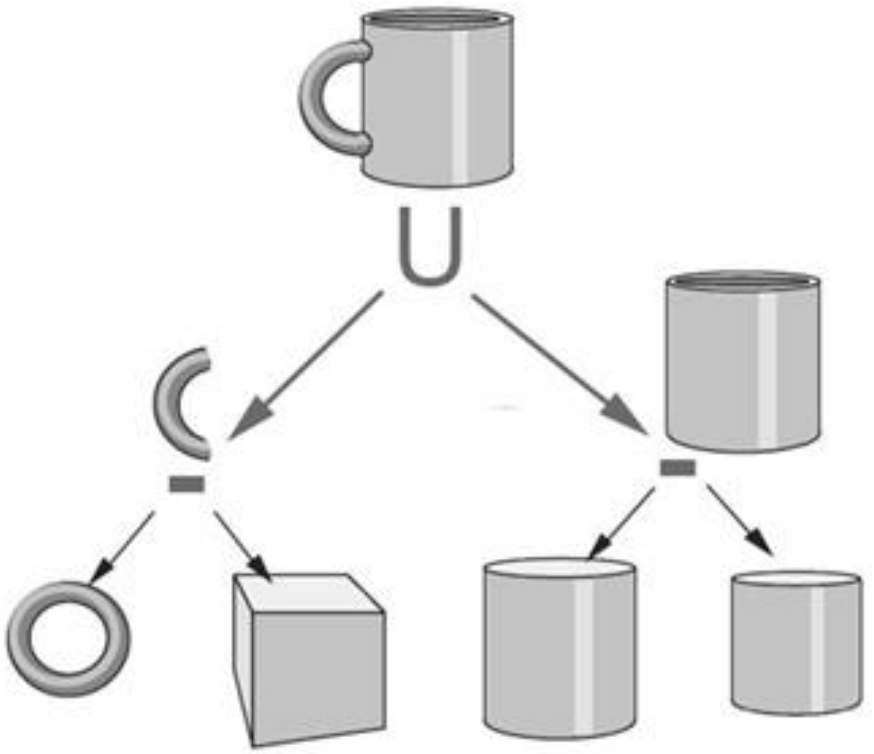
Union

Intersection

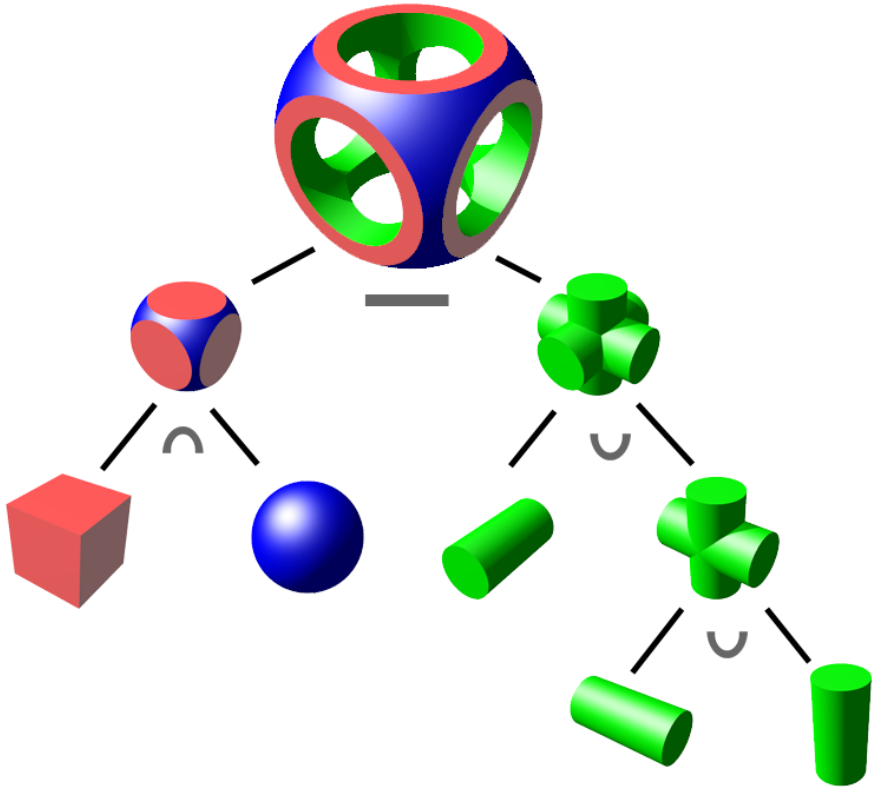


Difference

CSG Example



CSG Example



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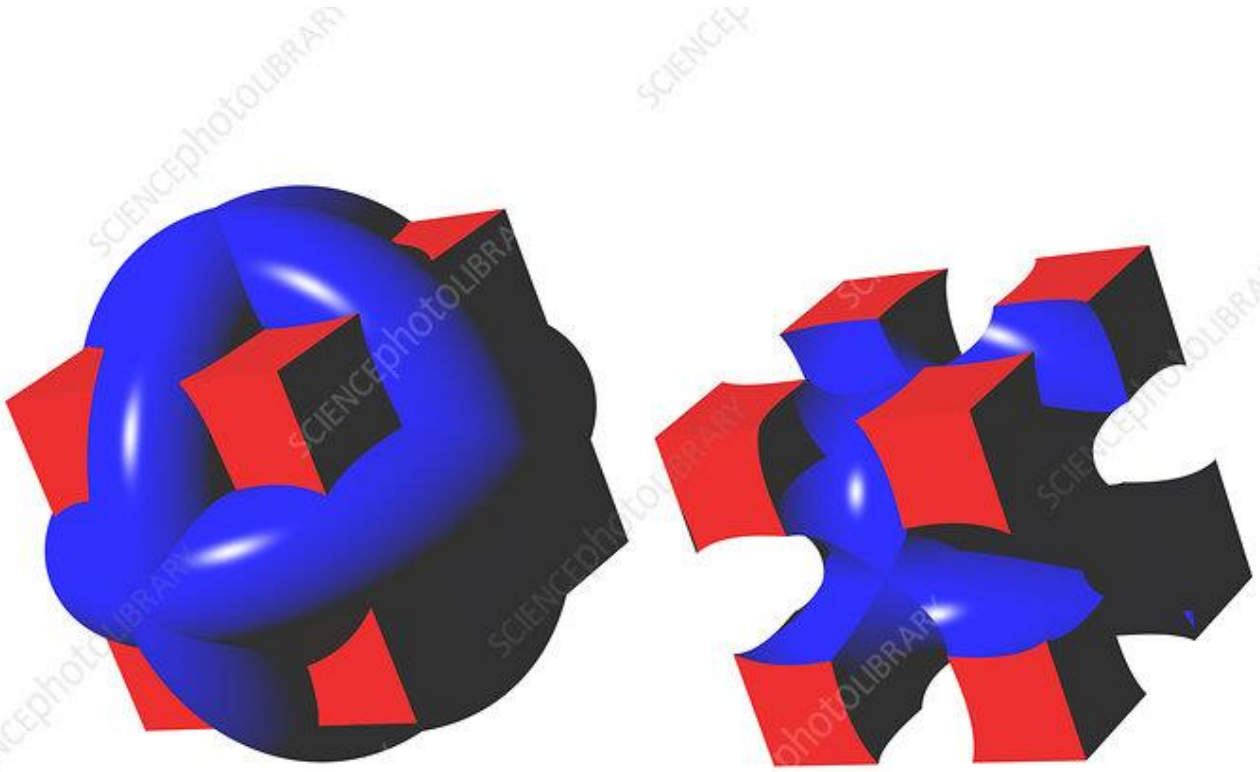

Thank You